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***XXVII.** *Experiments and Observations upon a blue Substance, found in a Peat-moss in Scotland: By Sylvester Douglas, Esquire.*

Read February 13, 1766. **T**HE blue coloured substance, which is the subject of the following observations, and which is now before you, was accidentally dug up in the summer 1759, in order to mix with some other materials for the purpose of manure, to be laid on some ground, at present in my possession, in the north of Scotland, about twelve miles from Aberdeen.

I have not met with a description of this substance in any naturalist. Kentman indeed in a few lines mentions a blue earth, which he calls *cæruleum Patavinum*, which agrees with the substance I am about to describe, in one remarkable circumstance; that it is at first of a white colour, and becomes blue only in consequence of being exposed to the air. Mr. Da Costa's *ocbra friabilis cærulea* †, would also have been found probably to correspond with it, if a more particular account could have been given of the circumstances in which it was found, and its appearance before the air had acted upon it. Mr. Cronstedt, in

* This paper, having being mislaid, could not be printed in the Volume of the Philosophical Transactions for 1766.

† Nat. Hist. of Foss. p. 103.

his late System of mineralogy, mentions a blue substance, which seems to be of the same kind, and which, I think, he says, is found somewhere in Prussia. His account of it is very short; and I am not very certain with regard to it, as I have not the book by me.

The place, where it is dug up, is of a marshy nature, in the corner of an exhausted peat-moss. Immediately under the sward lies a *stratum*, about a foot deep, of common peat; next to that is the substance itself, with irregular *striae* of a peaty matter all through it, to the depth of near another foot; and below this, I think, there is clay. While it is thus wet, and shut out from the air, it is of a white colour, and seemingly of a fatty consistence, not unlike lime that has been prepared for cement. All the water in the neighbourhood of the place is in some measure impregnated with iron. When this substance is exposed to the air, it gradually as it dries assumes the blue colour; the peaty matter intermixed with it continuing of the same appearance as before. The whole mixed mass is of a very friable texture, easily crumbling betwixt the fingers; and the blue part, gently rubbed between them, feels like a fine impalpable powder. It has hardly any sensible taste; what it has, approaches a little to that of sulphur: the smell, when it is first taken up, is sensibly sulphureous, and if a piece of paper, with part of it adhering to it, be kindled, it shews a flame similar to burning sulphur.

The only means of separating it from the black matter is by elutriation. When water is poured on it, and they are shaken together, and then left at rest for some time, the black part subsides to the bottom,

and the blue can be poured off still diffused in the water, from which however it soon separates, and falls to the bottom. It is not possible entirely to free the blue from the peaty matter, for, after above twenty different additions of water, there were still streaks of black interspersed through it, when it was allowed to subside; neither have I ever been able to separate all the blue from any of the black part.

When a little water is added to a quantity of it, it acquires some degree of tenacity, and when a small portion of water is allowed to stand on its surface for a day or two, the water becomes of a yellowish colour.

These are the chief circumstances relating to its natural history, and the obvious properties it discovers without the assistance of chemical operations. The following are the experiments I have made upon it, with a view to discover its nature more particularly.

In order to find whether there was any part of it soluble in water, I passed a large quantity of water, which I had used in separating the black from it, through a filter, and then set it to evaporate in B M; but there was nothing left in the vessel after the evaporation, except some earth, which the water had probably contained in itself.

To a quantity of the blue powder, I added the common vitriolic acid of the shops; a degree of effervescence ensued, and a considerable froth remained for some time on the surface; the whole was changed into a dark brown colour, and, when filtrated, the solution was a transparent brown liquor. A considerable sediment remained behind on the filter; but I am inclined to think, that this consisted chiefly of the
peaty

peaty matter, which had not been entirely separated; for when the experiment was repeated several times with different parcels of the blue, it appeared more or less soluble according as the black had been more or less perfectly separated; and when I added the vitriolic acid to a quantity of the black, though it turned it all of a brown colour, it only seemed to dissolve a quantity equal to the portion of blue, which still adhered to it.

The nitrous acid, added to the blue powder, produced pretty much the same effects, only the filtrated solution was of a much lighter brown.

The fixed vegetable alkali dissolved also a considerable part of it; but whether the whole or not, I cannot say. The solution was an opaque brown liquor, which did not become transparent after being twice filtrated, though it deposited no sediment upon standing several days.

I added a small quantity of volatile alkali to it, which seemed to dissolve part of it, and turned the rest obscurely green.

To the solution in vitriolic acid, I joined some fixed vegetable alkali: an effervescence arose, and a light curd of a colour between green and blue was thrown to the top, which soon subsided, and became white.

A similar præcipitate was obtained from the nitrous acid, only it was not at first thrown up to the surface in the same manner as the foregoing.

From the solution in fixed vegetable alkali, a reddish brown præcipitate was obtained, by the addition of vitriolic acid. Equal quantities of the blue powder and of black flux were mixed together, and being

put into a crucible, were kept in a strong degree of heat for several hours: on being removed, and taken out of the crucible, the whole was found concentered into a spongy mass, the bottom of which was cruſted over with ſomething that had a kind of metallic appearance. This maſs was powdered, and the lighter parts waſhed off; after which, a magnet was applied to what remained, and it attracted many of its particles ſtrongly, without being brought in contact with them.

Part of the white præcipitate from vitriolic acid was mixed with a little fixed alkali, and being laid on a piece of charcoal, the flame of a candle was directed to it by means of a blow-pipe. It was thus kept in a red heat for about an hour, and on being removed, the magnet was applied to it, but none of the powder was attracted by it. The quantity that can be examined in this way does not exceed a few grains.

To a ſmall quantity of the white præcipitate, I added an infuſion of tea; which turned it blue, approaching to the original colour, but not ſo deep.

To another parcel of the ſame, I added ſome infuſion of galls, and ſhook them together. The liquor became of a dark blue colour, and what part of the powder remained at the bottom of the glaſs was of the ſame colour. This was not ſo bright as that of the original powder diffuſed in water, but entirely ſuch as might be expected from the diffuſion of it in a brown liquor like infuſion of galls; and, to ſhew this, I poured ſome of the infuſion of that aſtringent on the blue ſubſtance itſelf, and on ſhaking them together, they produced a colour almoſt entirely the ſame.

A quantity of the brown solution in vitriolic acid was diluted with water till it became very pale. I then poured to it some infusion of galls, which turned it immediately black.

A parcel of the blue substance, being placed at the distance of a foot from the fire, was changed to a greenish colour.

These experiments, compared with its natural history, seem to throw some light on the nature and composition of this curious production. It is the known property of all vegetable astringents, to affect the colour of iron, either when it is combined with vitriolic acid, in the form of green vitriol, or by itself; and I believe they have no such effect on any other metal. The colour they produce with it is various, inclining indeed to black, but almost of every different shade between black and blue; and it seems to me, that they occasion a more pure black with vitriol, and a purple blue with iron itself, as is seen for instance on dropping a little infusion of tea on a knife.

Now we find, that when a vegetable astringent is added to a solution of this substance in vitriolic acid, it strikes a black colour with it, and restores the original blue to the white præcipitate from that acid. We also find, that there actually is iron contained in it; because, when fluxed with the black flux, its particles are attracted by the loadstone; and we can draw no argument, from our not having discovered iron in the experiment with the blow-pipe, against the presence of that metal, as so little can be examined in that way. I therefore think it probable, that the principal ingredients of it, and those on which its colour

colour depends, are iron and some vegetable astringent. The situation in which it is found favours this conjecture very strongly ; for, in the first place, the water in the neighbourhood of it is all impregnated with iron ; and secondly, in almost every peat-moss, there are the remains of oak trees, still fresh dispersed through them ; and both their wood and bark are of a strong astringent nature.

I do not pretend to say, that these are its only ingredients. I think we may conclude, from the lightness of the substance, that iron does not form a very great part of it ; and the smell, and the particular flame it exhibits in burning, would seem to shew the presence of sulphur in it. This, however, can be only in a very small proportion, since so much of it is soluble in acids, which do not at all affect sulphur. I suppose the præcipitate from acids consists chiefly of iron and earth.

I have made some trials on the blue powder after it was partly well freed from the black matter, in order to see how far it might be useful as a paint : a quantity of it was rubbed in a glass mortar with oil of walnuts ; but, after being thoroughly mixed with the oil, its colour was changed to black. It is probable, therefore, that little can be expected from it as an oil colour ; but it retains its natural brightness when mixed with gum-water ; and, as it is naturally in a very fine powder, it is diffused intimately through it without any difficulty, so that, if it could be got in sufficient quantity, it would be a cheap and usefull water-colour. I think there is reason to believe, that it might be found in most peat-mosses, as what seem to be the materials of which it is composed are pre-

sent almost in all of them. Two or three years ago a gentleman sent me a parcel of it, which he found in a moss on his estate, five or six miles distant from the place where I first observed it. I am informed, that Mr. Da Costa has had specimens of a blue earth sent him from different parts of England : what Sir Hans Sloane gave him from Ireland seems also to have been the same , and, from what I have quoted from Kentman and Cronstedt, it would appear, that it is obtained on several parts of the continent. From all this, I think we may conclude, that it might be procured in sufficient quantity to be a cheap paint ; particularly as it is in a manner levigated and prepared by nature.

It is to be lamented, that its colour is so easily affected by alkalies, especially the volatile alkali, which abounds so much in the atmosphere in towns, and by any considerable degree of heat. I have, never however, found any change produced on it from being exposed for a considerable time to the air, or to the heat of a room where a fire was kept constantly burning.